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OFFICIAL PROCEEDINGS
Meeting of Nov., 1919.

Volume XVIII.
No. - - - 8

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INCORPORATED OCTOBER 1918

Canadian Railway Club

MONTREAL

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REPORT OF NOVEMBER MEETING

AND

PAPER ON "TERMINAL POWER PLANTS"

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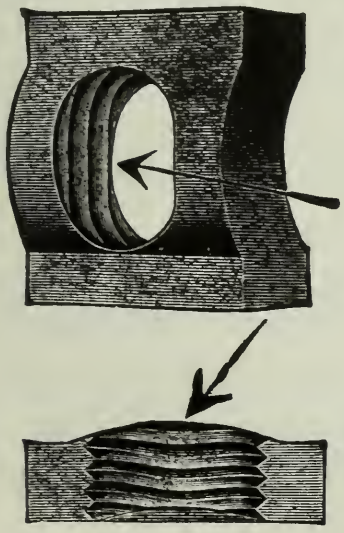

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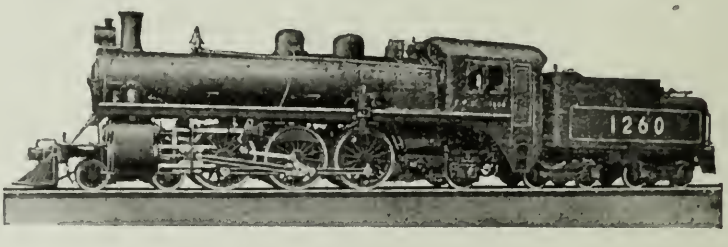

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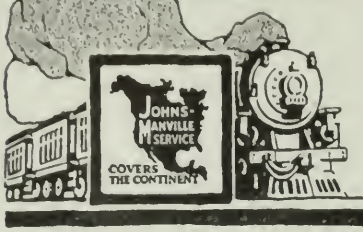

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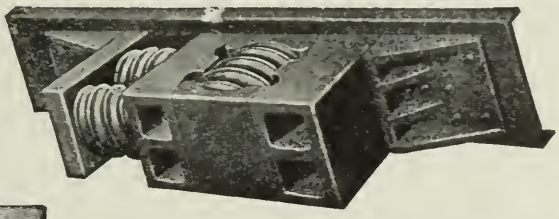

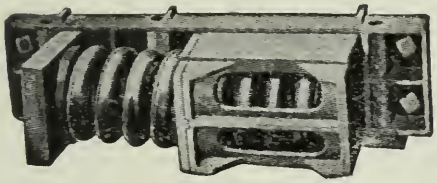

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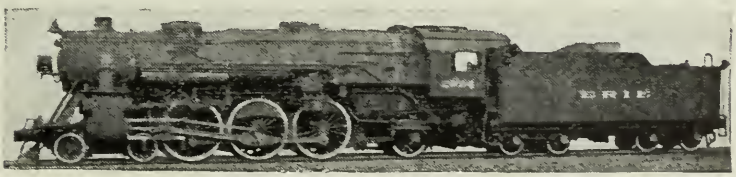

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W. A. BOOTH, Secretary, 131 Charron Street, Montreal.

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PROCEEDINGS OF THE CANADIAN RAILWAY CLUB.

Windsor Hotel, Montreal,
November 9th, 1919.

Chairman:—(Mr. J. Hendry.)

The members will please come to order. The first order of business is the signing of the cards which you will find in the seats. The members will see this is carefully done so that the Secretary may have a record of the attendance. The minutes of the previous meeting have been printed and have been forwarded to you. The next order of business is the remarks of the Chairman, but I do not intend to take up any of your time just now and will move on to the next item of business which is the reading of the list of new members.

Secretary:—

Mr. President and gentlemen, I have received applications for membership from the following gentlemen, these have been presented before your Executive Committee and are now read for your approval.

New Members.

Thos. Anderson, Rule Instructor, Grand Trunk Railway, 42 Charron St., Montreal.

T. G. Atkinson, Engr. Representative, G. & J. Weir, Ltd., Glasgow, c/o Peacock Bros., 285 Beaver Hall Hill, Montreal.

J. Ashworth Baxter, Construction Engineer, Bell Telephone Co., 251 Rielle Ave., Verdun, Que.

Wm. A. Berger, Representative, W. H. Miner, Queen's Hotel, Montreal.

W. A. Black, Locomotive Foreman, Canadian Pacific Railway, Farnham, Que.

A. J. Campbell, Consol. Steel Corporation, 263 St. James St., Montreal

John H. Dicken, Mechanical Draughtsman, Canadian Pacific Railway, 54 St. Matthew St. Montreal.

B. J. Dunlop, Travelling Insp., A., B. & Lub., G. T. R., Car Dept. Office, Montreal.
Geo. Fisher, Gen. Travelling Car Inspector, G. T. R., Montreal.
R. G. Gilbride, M. E. Motor Mechanics, 440 Western Ave., Westmount.
B. T. Horn, Mechanical Draughtsman, Room 1100 Windsor Station, C. P. R.
J. H. McAlpine, M. M., C. N. Rly., 517 Christie St., Toronto, Ont.
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C. E. Young, Rep., Standard Mch. & Sup., Ltd., 261 Notre Dame St. W., Montreal.

Chairman:—

Gentlemen, you have heard the list of applications for membership. What is your pleasure?

Mr. E. J. McVeigh:—

I move they be accepted.

Mr. W. C. Hunter:

Seconded.

Chairman:—

It has been moved by Mr. McVeigh, seconded by Mr.

Hunter, that these names be accepted. Are all in favor? Carried.

MEMBERS PRESENT.

Hendry, J.	Harrison, E. V.	Powell, C.
Archibald, P.	Holland, Norman	Powell, Jas.
Arnold, D. R.	Hudson, G. F.	Prowse, Wm.
Baxter, Jas. A.	Hudson, T. C.	Pyne, R. A.
Black, R. H.	Hunter, W. C.	Rake, H.
Boyer, Geo.	Larkin, L. O.	Robb, J. B.
Brady, F. P.	Lloyd, E. E.	Robb, J. D.
Campbell, M. M.	Lyttle, A. C.	Robb. W. H.
Clegg, W. H.	MacKie, R. L. D.	Sleigh ,T.
Coleman, Milton	Mackie, R. L. D.	Smith, E. D.
Cowan, R.	Marshall, T. M.	Soltau, G.
Cunningham, E. A.	McCarthy, J. J.	Spidy, E. T.
Dickenson, T. E.	McCracken, F. C.	Stewart, W. H.
Dyke, H. J.	McKinney, H.	Swinton, H. P.
Evans, W. E.	McVeigh, E. J.	Tetlaw, H.
Gant, T. D.	McVicar, Robt.	Thorp, H. W.
Gillespie, W.	Miller, M. J.	Wells, C. W.
Gordon, G. H.	Moore, F. W.	Yost, W. H.
Gregory, W. A.	Nix, E. A.	Young, C. E.
Hannah, D.	Palme, John E.	Booth, W. A.
Hannah, W. D.	Peacock, R. W.	and many others
Harding, W. J.	Pearse, H.	

Chairman:—

I have now much pleasure in caling upon Mr. W. J. Harding, Chief Engineer, Ottawa Power Plant, Grand Trunk Railway, to read his paper.

Mr. W. J. Harding:—

It gives me great pleasure to read this paper before the members of the Canadian Railway Club. As it is the first time a paper of this kind has been read before the Club I hope it will prove interesting.

TERMINAL POWER PLANTS

The object of this paper is to introduce Stationary Power Plants into the Canadian Railway Club. But I shall only discuss the subjects this evening in a very broad manner allowing future papers to bring out the finer details.

The very rapid development of the power generation and distribution business in the last 30 years has shown the difference between the actual life of power generating machinery and its useful life; or its life up to the time that it is superseded by larger and more economical apparatus or machines better suited to changed conditions of power generaton. So much depends upon the design and the conditions of operation that no fixed values can be assigned to any equipment. Practice shows that most Power Plant appliances become obsolete long before the limit of their useful life is reached.

At the present time there is renewed agitation for the use of higher pressure steam, and a number of manufacturers are ready to supply steam at 600 lbs. pressure and 200 degrees superheat. The turbine manufacturers are prepared to offer turbines to utilize this high pressure steam. Whether these changed conditions will result in a new type of station cannot be stated, but it is certain that additional operating economies may be secured, although the total economy when fixed charges are considered, may not be much better.

Probably the best illustration of compact power installation to meet the heating, ventilating, lighting, power and sanitary demands is found in the plants of modern Hotels, Railway Terminals and large office buildings.

Data from a large number of plants show the costs of electric current, etc., to be made up of: labor, coal, handling ashes, water, oil, lamps, supplies and repairs, interest and depreciation, also, central staion service, when used for periods of minimum consumption to allow shutting down of plant.

Roughly the figures average 1/3 labor, 1/3 coal, 1/10 interest and depreciation and the sum giving the cost of power as made up of the minor items.

The mean load throughout the day is usually 50 per cent. of the full load. The maximum is only required an hour or two late in the afternoons during the winter months. It is customary to allow about 40 per cent. reserve over the estimated peak loads in designing the boiler plant.

BOILER ROOM EQUIPMENT.

Type of Steam Generator.—The type will depend entirely upon conditions of service and space.

Modern Plants using high pressures invariably install

water tube boilers; they are safe, more economical and will meet the varying demands better.

For reasonably low pressures in small plants and for heating installations the ordinary fire tube boiler meets the requirements, if overload capacity is not an essential factor. These boilers are cheaper and cost less for repairs than water tube boilers.

Mechanical Stokers.—The difference between good and bad firing may easily amount to from 5 to 20 per cent. of the amount of fuel fired. Therefore, there is no investment around a steam plant that will pay better than the amount put out to produce good boiler appliances.

Automatic stokers have been developed to a remarkable degree of perfection and when suited to the fuel have an advantage over hand firing in that under all conditions they are reliable, that can be adjusted to either extremes and can be depended upon to operate continuously with the least amount of skilled labor. The economic saving will depend on the basis of comparison and operation. Whether a stoker will save labor in a fire hole depends upon the size of the plant; as a rule mechanical stokers are not **labor** saving devices in plants under 1,500 to 4,500 H.P.

It should also be remembered that unless the type of stoker is suited to the kind of fuel obtainable the maintenance of the stoker is likely to be extremely high, running in some cases to twice as high as fire room labor under hand-fired conditions.

Boiler Feed Pump.—It is the tendency of Railroad Power Plants to install reciprocating pumps; these are wasteful and inefficient. It is not an uncommon thing to find the steam consumption of an ordinary 6″ x 4″ x 6″ duplex pump to run up to 200 lbs. per Horse Power.

The modern turbine driven centrifugal feed pump requires almost no attention and a large saving can be made due to the absence of pump valve renewals, etc. The steam consumption of the turbine oven when running non condensing is reasonably low due to the high rate of rotation. Even when the pump is run as low as 1,800 R.P.M. the steam consumption of the turbine when run non-condensing would not exceed 50 lbs. per H.P., and the consumtion will not increase with the age of the pump as is the case with reciprocating pumps.

Open Feed Water Heaters.—The most profitable use to be made of exhaust steam is in heating the boiler feed water, since not only is heat conserved and fuel saved, but

the boilers are protected from temperature strains, the water is purified by the driving off of the gases and the consequent precipitation of carbonates, the capacity of the boiler is increased in the ratio borne by the heat imparted to feed water from exhaust steam to the total amount of heat required to convert the cold water into steam, or from 10 to 16 per cent. It is claimed that for every 11 degrees that the feed is heated there is a saving of 1 per cent. in fuel burned.

REFRIGERATION IN HOTEL SERVICE.

The capacity of a refrigerating plant is expressed in two ways, "ice melting effect" and "ice making."

For example,—A 20 ton machine will produce the same cooling effect in 24 hours as the melting of 20 tons of ice, or in other words, will extract the same amount of heat from the brine as would be required to melt 20 tons of ice into water at 32 degrees. Theoreticaly the extraction of this amount of heat from 20 tons of water at an initial temperature of 32 degrees should change it into ice, but in practice there are various losses not present in the simple process of cooling, so that it is customary to allow for twice the boiler power per ton for ice making as for the process of cooling or ice melting effect; the indicated H. P. required per ton refrigeration depends upon suction and condensor pressure which in turn are governed by the temperature and amount of condensing water used.

POWER PLANT RECORDS.

One of the most essential things in power plants is the systematic record of operations by daily logs and recording apparatus, and when the results are published on Engine Room bulletin boards it creates a rivalry between the different shifts and promotes a desire among the men for higher efficiency. The importance cannot be over-estimated. In this way affairs in the plant are lifted from the realms of guess work to certainty. While the systems adopted for ordinary plants may be simple, the records should be arranged for convenient reference so that comparison of results with past performance may be made. Thus it is possible to note the effects of changes in equipment or improvements in economy, or the reverse may be at once detected.

HEATING WITH EXHAUST STEAM FROM POWER PLANT.

Exhaust steam heating by vacuum systems has developed rapidly during the last few years. With its decided advantages over the old style methods of heating, it practically predominates the heating field. A description of the general principles and advantages may interest the members present.

The advantages of the vacuum system over the gravity system may be summarized as follows:—

1. Positive circulation by prompt removal of air and condensation through the vacuum returns.
2. Smaller return pipes, asbestos covering on returns can be eliminated so that the condensation can be handled by the pumps without the injection of cold water.
3. Increased economy, as back pressure on engines can be reduced to practically atmospheric.
4. Air binding and water hammer trouble removed.

The System in use at one large plant I am acquainted with is the Dunham Vacuum System. It was installed in the place of the old gravity system in which we used high pressure steam, which was unsatisfactory, wasteful and difficult to control under quick changes of temperature.

OPERATION OF THE SYSTEM.

The Vacuum was maintained by a Tod-Attwood 6″ x 8″ x 10″ pump and controlled by a ¾″ Fisher Vacuum Pump Governor, which is operated by a diaphragm and actuated by the vacuum produced in the return header.

The condensation is removed by the operation of a Thermostatic Trap connected to each radiator.

This trap is comprised of a shell consisting of a body and cover. Attached to the cover is a hollow disc or diaphragm containing a combination of volatile fluids which vaporize at about 200°. Attached to this diaphragm is the valve of the trap which raises and lowers on its seat as the disc or diaphragm expands or collapses.

The condensation from these traps are pumped into a sump from which an electric centrifugal pump actuated by a float delivers it to the boiler feed pump through a Cochrane Heater.

During the winter the hot water heater supplying the offices is heated with this condensation which passes di-

rectly through the chamber and is connected to the Vacuum Pump.

The total square feet of radiation in station is 6,200.

Low pressure condensation equals .25 lbs. per sq. ft. per hour. High pressure condensation equals .4 lb. per sq. ft. per hour, showing an approximate saving of 35%.

Chairman:—

I would like to state that we have listened to a very able paper, and we shall be pleased to have a good discussion on it. It is now before you gentlemen—

Mr. W. J. Harding:—

If any of the members present have had any experience in the use of high pressure boilers—of over 300 or 400 lbs. pressure—I would like to hear from them. There is a boiler on the market now, 1,000 h.p., 600 lbs. pressure, built by the Talbot Egineering Company, New York. I would like to hear from anyone who knows or has heard anything about it.

The Secretary:—

I should like to ask the speaker of this evening what means are employed to take care of the expansion and contraction of the many pipes that must lead from the boilers into the different buildings. I have been thinking this matter over, and there must be some unique means of taking care of same.

Mr. W. J. Harding:—

The usual method employed is the use of expansion joints or cantilever swing irons. That is about the best system I have seen. The one at Ottawa has been in service for about eight years and there are no leaks.

Mr. W. H. Robb:—

As there seems to be quite a lull here I might start a little discussion. In reading this paper over I began to think about the people who go to church, and when they come home they can tell you all about what the preacher should have said and how he should have said it, and from that I thought of the people who go to the show and can afterwards tell how the actors should have acted, although they are not actors. On these grounds I thought I might say something about this paper, although I do not know

much about power house work, but if I am able to say something which will cause the members to get up and talk, so much the better. On page 16 it says that most power plants become obsolete long before the limit of their useful life is reached, and on page 17 it says that it is the tendency of railroad power plants to install reciprocating pumps which are wasteful and inefficient. After seeing a great many reciprocating pumps I have come to the conclusion that Mr. Harding has said a whole lot right here. I have seen a good many reciprocating pumps that did everything but climb the wall—laughter—and they are no doubt a great source of trouble and labor to the power house engineers. Whether Mr. Harding's suggestion to do away with them will overcome the trouble I do not know, but I do know that this trouble exists and it is very great. On page 16 it says "Probably the best illustration of compact power installation to meet the heating, ventilating, lighting, power and sanitary demands is found in the plants of modern hotels, railway terminals and large office buildings," and at the bottom it says, "It is customary to allow about 40% reserve over the estimated peak loads in designing the boiler plant." I think that what Mr. Harding has in mind is the ideal condition, as I do not believe it is customary to allow 40%. I know that in a good many power plants I have visited it was not customary to allow 40% in designing them, or if it was they did not do it.

Mr. W. J. Harding:

Are you referring to railway power plants or other plants? The railway plants generally have a battery on the line and one battery out for cleaning. Other plants are generally run at their maximum the same as a locomotive.

Mr. W. H. Robb:—

What I meant to convey was that there are a good many buildings and manufacturing plants designed and it is not until the plant is about completed that they find they have to have a power plant. The plans are then got ready and the power plant is installed in a hurry. They also put in a couple of additional pumps for which there is no room and place these pumps at a point where they will cause the most trouble—laughter. Another thing is power plant records. I know that Mr. Harding keeps very good records. It says here: "In this way affairs in the plant are lifted from the realms of guess-work to certainty." There are

many power plants that have done a lot of guess-work in their day. I knew of an engine room where they had an engine working its head off, and the old fellow in charge was asked how much power it took to run her. He said he did not know, but did know that she was an "old devil." (Laughter.) While a lot of the bigger plants lead you to believe that they run on a swell organized system they no doubt still do a bit of guessing.

Mr. R. H. Black:—

Mr. Harding asked some questions about high pressure boilers. The only high pressure boilers I know of are those at the plant of the Illinois Public Service Co. at Joliet, near Chicago, which work at 350 lbs. pressure. They are Babcock and Wilcox boilers and are of a type specially designed for this pressure. The tubes are of heavy gauge; the drums 5 ft. in diameter, and the thickness of the plates in 1 5/16", also they have quadruple-riveted joints. When I came away they were designing a new plant of about 300,000 H.P., with boilers of the same type, but designed to work at 450 lbs. pressure. There was considerable work in designing these boilers and I do not know how they have got along with it, but it was very interesting in that they had two economizers, the feed water being fed through an ordinary economizer of the Green pattern; then to a booster pump; then through a high pressure economizer, with steel tubes and into the boiler.

Mr. Harding also made a remark about the reciprocating pump. To my knowledge, it is only during the past few months that a centrifugal pump has been designed that was simple enough to work in a small railway steam plant. Most of them are 1,000 H.P. capacity, and would not do for a 200 H.P. plant. There is now on the market a centrifugal pump which anyone would mistake for a headlight dynamo. It is designed for smaller plants and I think there is a good field ahead of it.

I should like to thank Mr. Harding for making an appeal for the recognition of our railway plants and their improvement. The railway stationary plants burn about as much fuel as the railway switch engines, but we should take into consideration that a much greater saving in proportion can be made in the stationary plant when it is run efficiently, and this feature is well worth considering. I might divide railway steam plants into two classifications: One would be the big terminal plant such as Mr. Harding has

charge of at Ottawa, and which are practically perfect, as they are very good plants indeed, and the other would be the round house plant which is just about as bad as it can be. A few years ago, the Chief Smoke Inspector in the city of Chicago made the statement that the railway plants were by far the worst offenders in regard to smoke nuisance and were the most inefficient in the city. I think that same statement will hold true on a great many roads, but it is also true that practically every road is preparing to adopt comprehensive plans for efficiency in steam plant work, and one of the chief difficulties in Canada in starting in on this efficiency work is the training of the stationary engineers and shop forces to properly care for and to understand the new apparatus which is committed to their care. A pump governor, a steam trap, or a temperature regulator is often condemned as too complicated by a man to whom the far more complicated details of the Westinghouse brake are an open book. It will be found that in any efficiency work the first thing to do is to create a department to supervise the work and train the men in plant operation. Another thing: I think that the power plants should be taken out of the hands of the locomotive and shop operating forces because these people consider the power plant a necessary evil. I should like to appeal for a separate department for the operation of railway stationary plants.

Mr. W. J. Harding:—

A good deal of the trouble in power plants to-day in Ontario is in obtaining engineers with certificates. In the past they have been using anybody they could get as long as he understood boiler practice, but in 1920 they are putting into force a law which involves an examination that will take almost a college graduate to pass and if any man can pass it he should be able to take care of any power plant. Referring to pumps: Mr. Black states that he thinks the smallest centrifugal pump made is 200 gal. per minute capacity, and while it may be too big for a plant such as at Ottawa it would not be too big for offices or hotels where greater capacity was necessary. At the present time our pumps feed 70 gals. per minute. During the summer we could run everything with electricity instead of steam. In Ontario they are trying to get up classes to instruct these esgineers because it is going to be a serious matter for some people, as the laws are so drastic that only about one in ten will be able to get the second class certificate.

A Member:—

Is the law retroactive.

Mr. W. J. Harding:—

No. The man has to send in details of his present occupation and size of plant and if he is the possessor of a 1919 certificate he is granted a new one to cover his plant, but will have to pass an examination if he leaves his present position to obtain first class papers if the plant he engages with is over 300 H.P.

I would like to ask Mr. Black what he thinks about the old locomotive boilers that are used in roundhouses for heating purposes.

Mr. R. H. Black:—

These locomotive boilers are not only inefficient, but they have no capacity whatever. About 40 H.P. is all you can get out of them unless you burn about five times as much coal. However, if kept within its rating the locomotive boiler is fairy efficient.

Mr. Norman Holland:—

Mr. Harding has referred to the vacuum heating system. At our plant we require at present about 2,200 feet and with the extension which we are putting up, will require about 4,000 feet. We use a Spencer furnace and it is extremely satisfactory. We have the Webster system. It has occurred to me that it might be good policy to adopt the vacuum system for heating. Have you any opinion as to whether it could be applied to the present Webster system without too much cost?

Mr. W. J. Harding:—

Most certainly—any system operated by steam can be adapted to the vacuum system of heating. The low pressure or gravity systems adapt themselves quite easily to the vacuum system. All you have to do is to put on thermostatic traps to release when the temperature drops.

Mr. N. Holland:—

Would you have to take off the Webster traps?

Mr. W. J. Harding:—

Yes, or refit them with Webster apparatus. It is not expensive. There are people in Montreal,—the Dunham

Heating Co.—who will look over your system and give you all the information you require. They have replaced the Webster gravity system in many cases. The Webster trap from what I can understand, is subject to air binding. The vacuum system will remove this trouble as it removes all the air and gives a perfect system. it will operate on one half a pound of steam. There is absolutely no noise at all after the traps are put on. Referring to the Dunham System; I am in favor of it because in the past we had considerable trouble at Ottawa and previously we used 40 lbs. of steam, but could not get satisfaction on account of pocketing, but now we have no trouble and are using about one-half a pound of steam and operating on three or four inch vacuum. It is very economical and practically requires no care.

Mr. R. H. Black:—

In reference to the Webster and Dunham systems: the Webster was the original thermostatic system and it has received a set back by reason of so many of the older Webster systems being inferior to the more modern Dunham and other systems. I am putting the Webster system in a big plant at Stratford and expect to get good results from it. The Webster people make as good a system as the Dunham people.

Mr. W. J. Harding:—

I was discussing with Mr. Black a short time ago this question of the Webster trap, but am strongly in favor of the Dunham type as it seems to clear itself of obstructions and seat itself properly.

Mr. R. H. Black:—

A great many were damaged due to high pressure.

Mr. W. J. Harding:—

Not at the Chateau at Ottawa.

Mr. E. J. McVeigh:—

The subject is hardly in my line and a little over my head in many respects, but I notice that Mr. Harding was careful not to go too far back in talking about his plant at Ottawa. He could go back and tell us some things which, while instructive, would be ancient history, and not perhaps be good policy.—notwithstanding this, it is a grand

thing to feel that the man who is discussing the subject knows considerable about it, but even that can be carried too far, and he might only touch the high spots and leave most of us behind him. Mr. Harding has a right to talk about his plant. He has made no failure of it, but that is not to be wondered at as I have known him to hold quite a few positions before he took charge at Ottawa and he never made a failure of any of them. I think I am safe in saying that the plant at Ottawa began to act right after Mr. Harding got hold of it, but whether it was due to his ability I am not prepared to say. I think, however, that he was responsible for some of the changes made which promoted its efficiency. I notice in his paper he speaks of 600 and 1,000 lb. pressure boilers. I would like to know something more about these boilers. I would like to know where they are so I could keep away from that place. (Laughter.)

Mr. R. H. Black:—

I think the boiler Mr. Harding refers to is yet in the experimental stage and has not yet been installed in any commercial power plant.

Mr. W. J. Harding:—

In regard to the Talbot Boiler I referred to. I have here a paper which was read before the 1919 meeting of the A. S. of C. E., which I will read. This boiler is at present in service in a number of the big boats of the U. S. Navy. It is really a water tube boiler with contra-flow circulation.

THE TALBOT BOILER

Abstract of Paper.

This paper describes the Talbot marine boiler. The boiler utilizes the principle of forced contra-flow circulation through water tubes at high velocity. Steam drum and water drum are unnecessary, so that danger from explosion is reduced to a minimum. Oil is spayed by superheated steam into the combustion chamber, which is lined on all sides with heating surface.

The tubes are screwed into headers, one end of the tube being free to expand. A field tube is placed inside a generating tube, and circulation is through the field tube and the annular space between the two tubes. The tubes are accessible from the front of the boiler and can be removed and replaced rapidly.

The supply of feed water passes through a regulator valve before entering the boiler. This valve is controlled by the expansion of one of the tubes of the boiler so that it opens and closes with varying temperatures of the steam within the tube. The fuel valve is also controlled by the expansion of this same tube so that the fuel supply is cut off if the temperature of the steam becomes greater than is desired. The control of feed and fire thus becomes automatic. A gage is provided for indicating to the operator the relative temperature of the steam.

The high velocity of water and steam over the heating surface prevents the formation of scale. Steam jets are provided for blowing soot from the outside of the tubes.

A high rate of evaporation is obtained, the average, including economizer and superheater surface, being 8 lb. of water per sq. ft. (16 lb. on forced draft.)

Because of the contra-flow principle, the effect of increased draft and higher evaporative rates is to increase the economizer surface of the upper tubes and to modify the stack temperature.

These people have an agency in Montreal and I am endeavoring to get blue prints so I can learn more about the boilers. They have had some under test at 1,000 lbs. pressure.

Mr. H. J. Dyke:—

I have seen one of these boilers at the Montreal Tool Works. They are down on Notre Dame Street. I was down there and they lit this boiler up. It had a pressure of 500 or 600 lbs. This boiler was rated at 1,000 H.P. or some such figure. It was only four feet high and six feet long. At the front there is a series of headers which are made of cast steel. In these headers were tubes. The inner tube was about ⅜″ thick and the outer tube ½″ thick. The water flowed through the inner tube and back on the outside of the inner tube. Quite a number of these tubes were attached to the header. I do not know the number, but if I had known this question was to be raised here I would have secured more information. The boiler was fired by oil. It would be interesting to take the speaker over and give him a description of the boiler. I also understand there is such a boiler in a private yacht owned by a Montreal gentleman and it has given good results. The great feature is the high pressure and the small space the boiler occupies.

Mr. R. L. D. Mackie:—

In using this high pressure boiler is it neccesary to reduce the steam before it reaches the cylinders on account of the lubrication and the strength of the cylinders?

Mr. W. J. Harding:—

No, not necessarily. I have not got the details, but I understand the pressure in the cylinders is about the same as the boiler pressure. They have a special designed engine constructed for the purpose.

Mr. A. E. Gulliver:—

There certainly has been rapid changes in power plant apparatus during the past few years. This I think has been due to the further development and adoption of the steam turbine. We all know that the average steam pressure for boilers in central station turbine power plants to be from 220 to 250 pounds per square inch, with about 100 to 150 degrees of superheat. Engineers then experimented with various types of surface, jet, and baromatic condensers. and wet and dry vacuum pumps. A vacuum can now be maintained to within a few tenths of the barometer. We all know that under operating conditions it is impossible to obtain an absolute vacuum, as even cold water in a vacuum will give off a vapor which would prevent you from doing this. The reason that has brought about the agitation for high pressure boilers is the still further strive for economy, and you cannot get any further in this direction by destroying the atmospheric pressure, having reached about a possible. You must now go to the other extreme and obtain a higher boiler pressure. I know of central station plants that are now, and have been for some years operating with a boiler pressure of 350 pounds per square inch. Experiments are now being conducted on boilers of the B. & W. type for pressures of 500 and 600 pounds per square inch, and the B. & W. people have stated that they can produce a boiler after their standard design with a little heavier plate and heavier gauge tubes that will withstand this pressure. We have reached the limit at the other end of it so that 600 pounds pressure has got to come and will come. Mr. Harding states that the water tube boiler is more economical and safer than the fire tube boiler, I agree with him on these points, but I cannot agree with him when he states that fire tube boilers cost less for repairs than water tube boilers. I have had a number of water tube boilers

under my supervision having 75 in one plant and 50 in another, and the only repairs have been tube troubles. In a fire tube boiler your repairs when needed are much more serious than in the water tube boiler. If a tube sheet blisters the blister will have to be cut out and the sheet patched, which is only a make shift, and to put the boiler in anything like proper shape you would have to apply a new tube sheet which is an expensive job, and the boiler would require to be retubed or you would not have room to drive the rivets. I have had experience with marine and other types of fire tube and internally fired boilers, with Foxes corrugated and plain cylindrical furnace tubes, and at times there is a tendency for these tubes to be out of round, and the external pressure on the tubes tends to increase this distortion and sometimes cause collapse, whereas in the water tube boiler the pressures are all internal which tend to restore any distortion that there may be in any of the cylindrical portions to their former shape. If anybody can tell me that they have had trouble with the water tube boiler, or that it is heavier on repairs than the fire tube I would like to hear from them.

Mr. W. J. Harding:—

When I referred in the paper to fire tube boilers in relation to water tube boilers I had in mind the low pressure boilers used for heating plants. I quite agree with you that the water tube boiler is better and more economical to keep up in the case of power plants, but for low pressure purposes the fire tube boiler is the better.

Mr. A. E. Gulliver:—

Even in low pressure work you evaporate considerable water and the life of the tubes will depend upon the quality of water you are using, and if the water is bad the tubes will need renewing in a short time. The return tubular boiler cannot be cleaned like the water tube there being no part of the latter which cannot be thoroughly cleaned. The drums of these boilers have no longitudinal stays or other obstructions, and therefore allow ample room for inspection and cleaning, and I am still of the opinion that the repairs of this type of boiler will cost less than the fire tube boiler, which is almost impossible to get clean on account of not being able to remove the scale on the tubes. It being impossible to remove same completely from the inside of the boiler, and if it is removed by a turbine hammer there is no

way of knowing how thorough a job has been done, and is a matter of guess-work. The result is you are going to have leaky tubes and frequent renewals. Then, the renewal of tubes in the B. & W. boiler is merely child's play. We have taken boilers off the line after the peak load at night, and next morning at 8 o'clock the men have started to work and renewed as many as nine tubes. and the same boiler would be cut in on the line again at 5 o'clock at night, and this was done by unskilled labor. The removal of tubes in the fire tube boiler is always difficult, due to hard deposits on the exterior which results from sediment accumulating and so enlarges the tube that it is often impossible to draw it through the tube sheet, and if a tube is defective it is often necessary to cut out other tubes so as to allow access to the one which has failed, and remove them through the manhole, —so I do not see how even in boilers carrying low pressures that there is any comparison whatever.

A Member:—

Have you ever seen a bulged tube.

Mr. A. E. Gulliver:—

A bulged tube is generally caused by laminations of scale when the circulation is bad at such places where the tubes are protected by the brickwork such as under the arch or at the bridge wall. These accumulations of egg shell scale cause laminations and will result in burning the tube.

Mr. H. J. Dyke:—

Have you ever seen boilers with defective tubes above the third row from the bottom?

Mr. A. E. Gulliver:—

No, I do not think I have. The tubes which cause the trouble are in the bottom rows. I think it is due to bad circulation at the points mentioned, I have found tubes with several bulges and the scale was not thick, but due to several laminations caused by egg shell scale, and this scale not allowing the proper heat transfer to the water results in tube burning.

Mr. R. H. Black:—

What percentage of rating were the boilers run at?

Mr. A. E. Gulliver:—

It is hard to answer that. The boilers are run at all kinds of ratings. It is hard to say at what rating the boilers were run when the trouble occurred, but they were run at a high rating and this does not affect the tubes as the circulation is better. A few years ago 125 or 150 per cent. of rating were considered high and 200 per cent. of rating very high, but at the present time these ratings are now considered more in the light of every day practice. Mr. Harding mentioned mechanical stokers. We have had a good many types on the market in the past few years, but I do not think that they are the only advantage in getting good results from boilers. There is the chain grate stoker which has been on the market since about 1,800 and something.

Mr. W. J. Harding:—

I think they have been a success, but you are correct about the date.

Mr. A. E. Gulliver:—

I think it was in 1871 that the first chain grate was brought out. It is my idea that the good results obtained are due more to the boiler setting. A few years ago the setting for a B. & W. water tube boiler, or the height from the front headers to the floor line was from 6 to 9 feet, and there were many engineers who thought that if the boiler was placed higher above the grates they would be less efficient, but with the development of higher capacities, boilers were set higher and higher and for stoker firing these boilers now have a setting from 12 to 14 feet. Another thing a few years ago two cubic feet per square foot of grate surface was fairly big for furnace volume, whereas to-day we figure on twelve cubic feet, while those having eight to ten cubic feet are the general rule. There are comparatively few boiler settings existing to-day which could not have their efficiency improved several per cent. with no change in apparatus, but by increasing the proportions of the furnace. Speaking of changes in furnaces—I know a power plant to-day that is operating on what we would call a waste product, that is old lumber from box cars, shop shavings, sawdust, and other refuse, this plant is evaporating 84,000 pounds of water per hour. One of the boilers which has a Dutch oven attached, and has a grate on an incline of 30 degrees giving the furnace more volume. This boiler under test has

evaporated as high as 40,000 pounds of water per hour, and operates at a 225 per cent rating or 125 per cent overload. This boiler has been operating for about twelve months and has shown no bad effects.

Mr. James Powell:—

Unless someone else has something to say on this subject, —I can bear testimony to the excellent and efficient manner in which the power plant at Ottawa is conducted under Mr. Harding's care. It is a credit to himself and the company. and I am sure that any member of the club who is visiting Ottawa would find it a treat to inspect this plant. I have much pleasure in proposing a vote of thanks to Mr. Harding for his paper.

Mr. E. J. McVeigh:—

I have pleasure in seconding that.

Chairman:—

It has geen moved by Mr. Powell, seconded by Mr. McVeigh, that a hearty vote of thanks be extended to Mr. Harding for his able paper.

Carried. (Applause.)

Mr. W. J. Harding:—

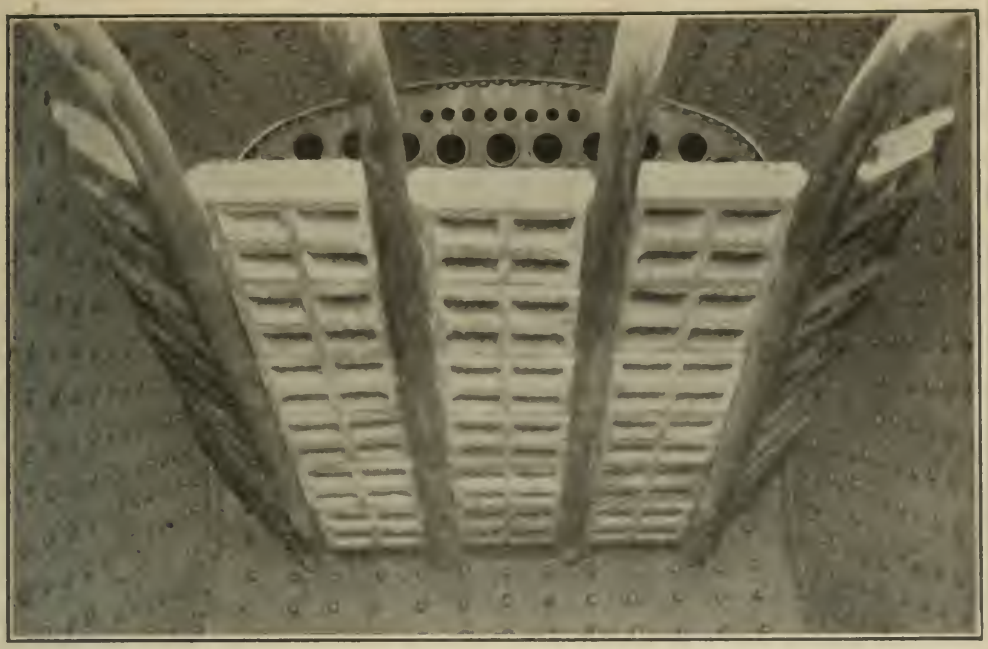
I thank the members for their appreciation of my paper and I hope it will be the means of bringing out more remarks on this subject, as apparently there are some members here who know considerably more about boilers than I do.

The Secretary:—

Mr. President and members, I wish to announce that at our next meeting we will have a moving picture programme, which will be rendered by Mr. E. E. Stevens, Safety Engineer of the Canadian National Railways, Moncton, N.B., entitled, "The House that Jack Built," and in addition to this a reel on "First Aid."

Chairman:—

The Secretary has arranged for coffee and sandwiches in the room at the rear. I hope all will stay and partake of them.



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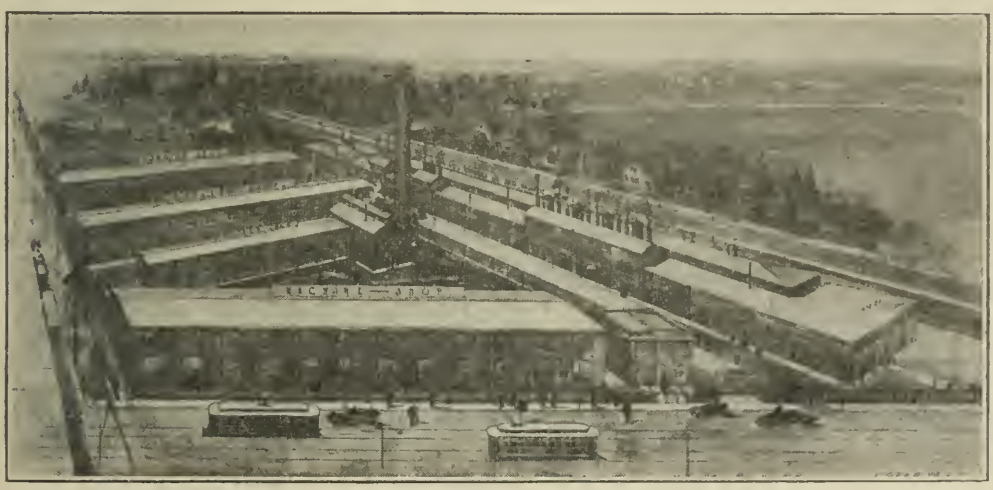

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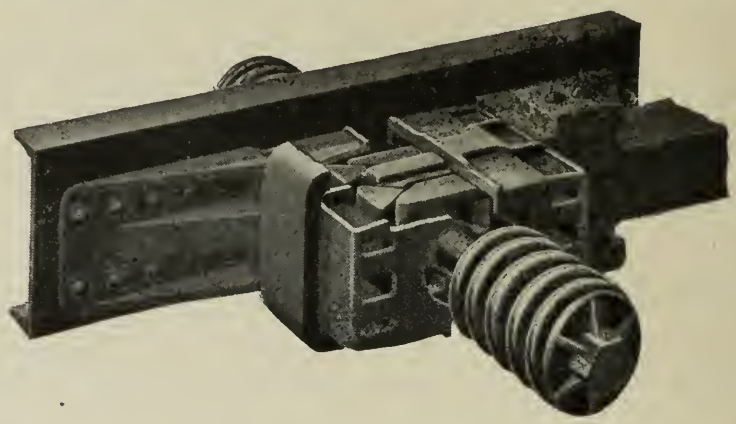

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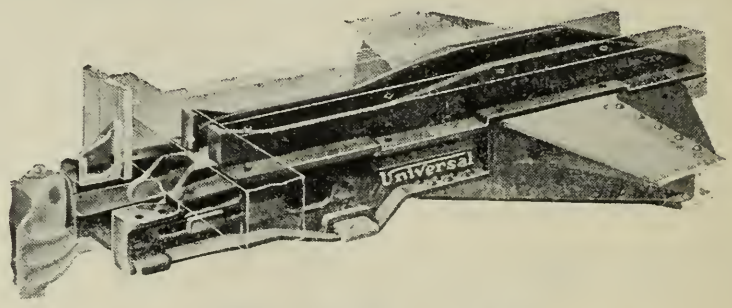

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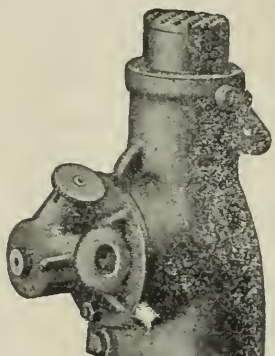

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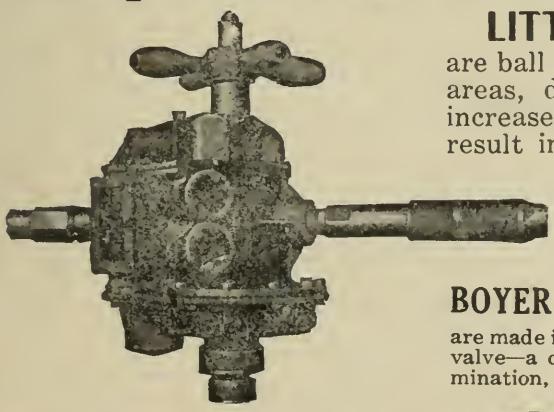

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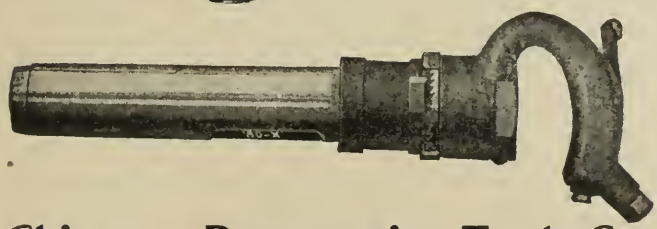

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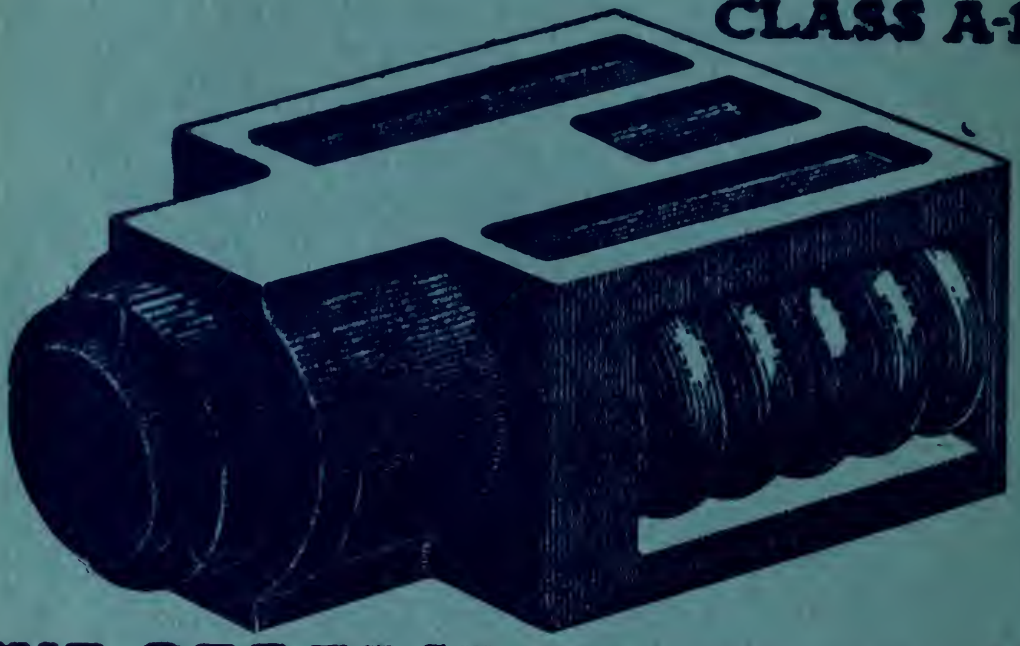

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